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D. Dimitrov

Investigation on the interference of low frequency currents in medical therapy

APPLIED ELECTROMAGNETISM AND CIRQUIT THEORY

An investigation on the space configuration of the field of current density **δ** in the process of interference of low frequency currents in the alive tissue is described in the paper. The vector of current density **δ** is connected with the vector of intensity of electrical field **E** by the electrical conductance of alive tissue *γ.*

(1) $\vec{\delta} = \gamma\vec{E}$. It's accepted in the paper that *γ=const*

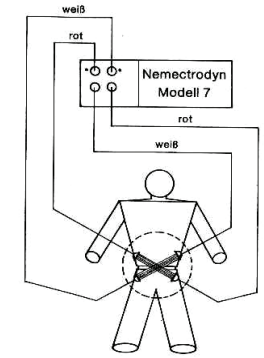

Fig.1

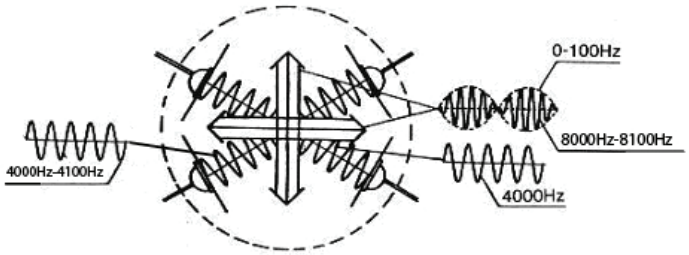

Fig.2

The investigation is done for the typical case of two independent current contours .The contours are connected to two independent generators of harmonic signals with different frequencies(Fig.1). The frequency of signal of the first generator is constant. The signal of the second generator is frequency modulated(Fig.2).Because of process complication there are some approximations, which don't decrease the possibility for practical applications of obtained results. The goal of this investigation is to provide a software package for computer visualization of the process of interference of low frequency currents in medicaл therapy. This visualization would be useful for physicians. There are some results on visualization, but usually these results are not enough correct and exact. It's necessary to do a preliminary mathematical description of the process of interference of the low frequency current in the alive tissue and then computer simulation of the space configuration of the field of current density in the process of interference of low frequency currents. If the amplitude of output voltage of the first generator is U_{1m} and the amplitude of output voltage of the second generator is U_{2m} it is clear that $E_1[U_{1m}(t)]$ and $E_2[U_{2m}(t)]$, where E_1 is the intensity of electrical field provided by the first generator in one arbitrary point M in alive tissue, E_2 is the intensity of electrical field provided by the second generator in the same one point M and t is the time. The frequency f_1 of the first generator f_1 = constant, but the frequency of the second generator f_2=var. There is a rotation of the vector

$\mathbf{E}=\mathbf{E_1}+\mathbf{E_2}$ in the plane of the two vectors with frequency $f=f_2-f_1$ The line of upper of the vector **E** depends to the angle α between two vectors $\mathbf{E_1}$ and $\mathbf{E_2}$ and to the relation $k= U_{2m}(t) / U_{1m}(t)$ between the amplitude of output voltage of two generators. In the paper there are described some experimental results of computer simulation of the above mentioned rotation of the vector of electrical intensity **E** in the cases of different value of angle α and relation k. The value of relation k can be provided by fine adjustment of the output voltages U1m and U2m of two generators. The angle α depends to the situations of the two pairs electrodes on the human body. A computer visualization of the line of upper of vector **E** in the process of rotation in the plane E1,E2 is very useful for the physicians . Some experimental results of computer simulation of above mentioned rotation are presented below(Fig.3) and (Fig.4).

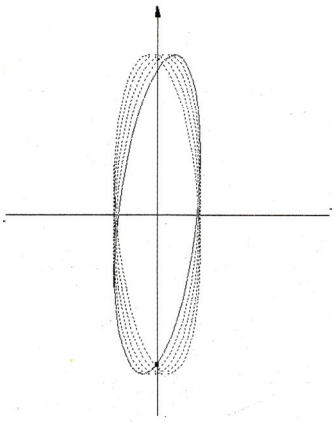

Fig.3 (k=2, α=π /2)

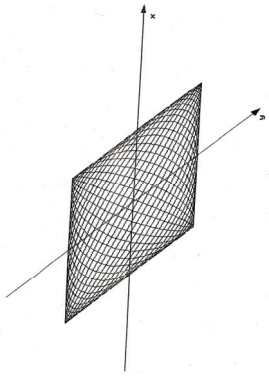

Fig.4 (k=1 α= π /4)

Conclusion:

A computer visualization of the rotation of the vector of electrical intensity **E** in the process of interference of low frequency currents in the alive tissue is obtained in the paper. This visualization would be useful not only for physicians in the process of therapy , but for engineering design of apparatuses for low frequency interference of current in alive tissue, also.

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